# APPLICATION NOTE A078-ST99 - WATER-REPELLENT FABRICS AND TEXTILES

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## WATER-REPELLENT FABRICS AND TEXTILES

**Waterproof yet breathable clothing prevents rainwater drops from penetrating, and at the same time allows perspiration vapour to pass - very desirable when exercising in the rain. And stain-repellent fabrics protect your clothes against coffee, juice or food stains. In both cases, a hydrophobic coating is responsible for the anti-wetting behaviour. How can you make fabrics and textiles hydrophobic or add other functionalities to them without affecting the bulk properties of their fibers?**

Empa, part of the Swiss technology institute ETH and devoted to materials research, investigates and applies plasma polymerisation to deposit thin, nanoscale layers on top of fabrics and fibers. This is done in order to functionalise their surface - and more specific: to make them water-repellent. Bronkhorst devices play an important role in this process, especially in the controlled supply of polymer precursors.

### Application requirements

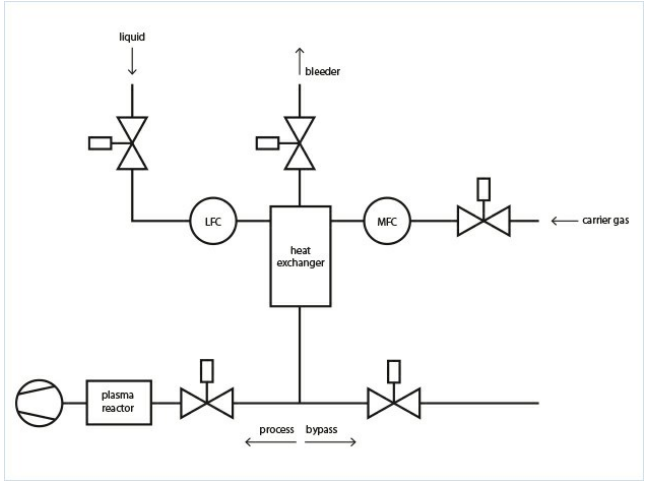
In the low-pressure (0,1 mbar) plasma polymerisation process at Empa, the liquid silicon-organic compound hexamethyldisiloxane (HMDSO - $C_6H_{18}OSi_2$) is evaporated and successively activated by the plasma with the aim to be polymerised and deposited onto the fiber surface as a hydrophobic coating. In order to obtain a stable and reproducible polymer precursor vapour flow, the liquid HMDSO flow as well as a carrier gas flow have to be controlled accurately. The HMDSO vapour is introduced into the plasma chamber at defined flow rates, where high rates promote high deposition rates and fast processing.

### Important topics

- Accurately controlled gas/liquid mixture
- Stable vapour flow
- Low to high vapour flow rates

### Process solution

The Bronkhorst CEM (Controlled Evaporation Mixing) system is used to evaporate silicon organic HMDSO. In this setup, liquid HMDSO is drawn from a container at room temperature and measured by a mini CORI-FLOW mass flow meter. Then the liquid HMDSO is mixed with argon carrier gas from an EL-FLOW thermal mass flow controller and vaporised inside a heat exchanger for controlled heating. The vapour flow is introduced into the plasma reaction chamber operated at 0,1 mbar absolute pressure. A PLC system controls the entire evaporation process. Using this setup, HMDSO is evaporated in a wide range of 1 to 30 grams per hour. First results show that vapour flows are generated in a stable, accurate, repeatable and well controlled way.




Flow scheme showing CEM evaporation system


LabVIEW software is used to visualise the evaporation process simply and effectively.The currently used CEM system has replaced a traditional and time-consuming bubbler system with a limited low flow rate of carrier gas and precursor. Using the CEM system, Empa obtains a higher yield of 50 ml/min of gas, whereas in the earlier bubbler system only 4-5 ml/min of gas flow was possible. Likewise the HMDSO liquid flow has been increased. Empa's aim for the near future is to upscale the process, from laboratory scale to industrial scale.

The currently used CEM system at Empa is mobile. This compact setup on wheels has the size of a small office table, which makes it possible to move the system from one laboratory to the other rather easy. The compactness of Bronkhorst devices is an additional advantage here to allow for special engineered flow soltuions. This HMDSO setup facilitates the deposition of polysiloxane coatings at a low temperature, which makes it feasible to coat textile fibres that cannot withstand high temperatures. Empa's attempts to conduct the plasma polymerisation at low pressure aims at increasing the production yield by promoting heterogeneous deposition on the fiber's surface, and by reducing the amount of chemicals.

## Recommended Products


### EL-FLOW SELECT F-201CV

Min. flow 0,16…8 mln/min
Max. flow 0,5…25 ln/min

Pressure rating 64 bar

Compact design

High accuracy and repeatability


### MINI CORI-FLOW™ M12

Min. flow 0,1…5 g/h
Max. flow 2…200 g/h

Pressure rating 200 bar

Independent of fluid properties

High accuracy, fast response


### CEM EVAPORATOR W-102A

Max. 30 g/h liquid;
Max. 4 ln/min gas

Pressure rating 100 bar

Very stable vapor flow

Flexible gas/liquid ratio


### VDM EVAPORATOR SW-100

Max. 30 g/h liquid;
Max. 4 ln/min gas

Pressure rating 10 bar

Very stable vapor flow

Pre-tested, safe and ready to use

**BRONKHORST USA INC.**

57 South Commerce Way

Suite 120

USA - Bethlehem, PA 18017

Tel. +1-610-866-6750

sales@bronkhorstusa.com